BULLETIN NO. 712 MARCH, 1945

# New York State Agricultural Experiment Station

Geneva, N. Y.

## FIELD RESULTS ON THE CONTROL OF CERTAIN GRAPE DISEASES IN NEW YORK

R. F. SUIT




PUBLISHED BY THE STATION
UNDER AUTHORITY OF CORNELL UNIVERSITY

## ABSTRACT

BLACK ROT, *Guignardia bidwellii* (Ell.) Viala and Ravaz; downy mildew, *Plasmopara viticola* (Berk. and Curt.) Berl. and DeToni; and powdery mildew, *Uncinula necator* (Schw.) Burr., are diseases of grapes which are of major importance in New York State.

The susceptibility to these diseases of the leaves and bunches of 11 varieties of grapes as observed under field conditions during 1940–44, inclusive, is recorded.

When bordeaux mixture was applied to plots previously treated with an eradicant fungicide, such as Elgetol, no increase in the control of any of the three diseases was obtained when compared with that which occurred in those plots sprayed with the bordeaux mixture without the eradicant treatment.

Concentrations of bordeaux mixture ranging from 2–2–100 to 8–8–100 gave effective control of black rot, downy mildew, and powdery mildew under experimental conditions. The 4–4–100 formula was as effective as the 8–8–100 and would be more reliable than the 2–2–100 for the control of black rot and downy mildew, while the 2–4–100 formula gave excellent control of powdery mildew.

Three applications of bordeaux mixture, before bloom, immediately after bloom, and 2 weeks after bloom, were sufficient to control downy mildew. This schedule also controlled black rot in the tests conducted in 1940 and 1941. However, five applications of bordeaux mixture were necessary in the 1944 tests. Two applications, one immediately after bloom and the second 10 to 14 days after bloom, gave control of powdery mildew.

Addition of rosin fish oil soap to the bordeaux mixture increased the disease control on the bunches but did not give any significant difference in the control of downy mildew on the foliage.

In general, better control of the three diseases was obtained with Yellow Cuprocide than with any of the other six insoluble coppers tested. None of the insoluble coppers gave better control than bordeaux mixture except in one or two individual tests.

In limited tests, three applications of Fermate, 2–100, showed better control of black rot than any other fungicide tested. An experimental material, U.S.R. No. 604 (2,3-dichloro-naphthoquinone), was superior for the control of downy mildew but caused some injury.

Bulletin No. 712

# FIELD RESULTS ON THE CONTROL OF CERTAIN GRAPE DISEASES IN NEW YORK

R. F. SUIT

## INTRODUCTION

In New York State there are three diseases of grapes that are of major importance. Black rot, *Guignardia bidwellii* (Ell.) Viala and Ravaz, is prevalent in the Hudson Valley and Finger Lakes regions and in some limited areas in the Lake Erie grape belt. Downy mildew, *Plasmopara viticola* (Berk. and Curt.) Berl. and DeToni, occurs in the Finger Lakes region and is found in a few vineyards in the Lake Erie grape belt. Powdery mildew, *Uncinula necator* (Schw.) Burr., is most prevalent in the Lake Erie grape belt but also occurs in the other grape regions of the State.

Many times, black rot and downy mildew have caused a total loss of the grapes in a vineyard, while usually a high proportion of the vineyards showed from 10 to 50 per cent reduction in the crop because of the ravages of these diseases. Powdery mildew did not usually cause a serious loss of the crop. However, it may attack the stems and pedicels of the bunches, causing them to shrivel. This loosens the berries which results in "shelling" from the bunches when they are picked or shaken by strong winds. The "shelling" of the berries is not desirable and reduces the value of the crop.

During 1939, diseases of grapes were generally prevalent thruout the State and many growers thought that they were not obtaining satisfactory disease control with the spray schedule that had been suggested (4)[1]. Consequently, it was deemed advisable to investigate the possible control methods to discover, if possible, where the difficulty lay.

Experiments were started in 1940 to determine the required concentration of bordeaux mixture, the necessary number of spray applications, the relative efficiency of fungicides other than bordeaux mixture, the effect of spreader-stickers, and the effectiveness of dormant sprays for the control of black rot and downy and powdery mildews. Preliminary reports were presented (11, 12) as the work progressed. Since these reports indicated that a reduced spray sched-

[1]Figures in parenthesis refer to Literature Cited, page 25.

ule gave satisfactory control and was more economical, the suggested spray schedule for the State was revised (9).

This bulletin presents the results of experiments conducted in 35 vineyards thruout the State from 1940 to 1944, inclusive, to develop economical and efficient spray schedules for the control of black rot, downy mildew, and powdery mildew on grapes.

## MATERIALS AND METHODS

During the course of the investigations, experiments were conducted in one or more years with Concord, Niagara, Catawba, Delaware, and Fredonia.

The following fungicides were included in the tests at various times: Elgetol, Elgetol 312 (contains 50 per cent more toxicant than Elgetol), D. N. Powder (D-145, Fusion mix of 40 per cent dinitro-orthol cresol and 60 per cent bentonite), bordeaux mixture (2–2–100, 3–3–100, 4–4–100, 8–8–100), Cuprocide 54–Y, Yellow Cuprocide, Basicop, Copper Compound A, copper oxychloride sulfate, Tribasic copper sulfate, Microgel, Fermate, and an experimental material designated as U. S. R. No. 604 (2,3-dichloro-naphthoquinone) from the U. S. Rubber Company, Naugatuck Chemical Division.

In the experiments on the effect of spreader-stickers on disease control, the following materials were tested: Rosin fish oil soap, S. E. C. oil (self-emulsifying cottonseed oil), Grasselli spreader-sticker, Triton B-1956, Spraysoy A, Liquid Orthex, summer oil (45-second viscosity oil plus 4 per cent Triton B-1956), and kerosene emulsion (1 part sulfonated oil base and 4 parts kerosene) as reported by Hurt (8).

All test plots were located in growers' vineyards which had been examined the previous year to determine whether a disease was of sufficient severity to give satisfactory results. Each plot consisted of a row 15 to 20 vines long and all spray treatments were randomized. The number of replicates of each treatment varied from two to four, depending on the arrangement which could be made in the vineyard selected for the experiment.

The sprays were applied from both sides of the row with a two-nozzle broom at a pressure of 350 pounds. In the experimental work, the sprays were applied at the rate of about 250 gallons per acre.

A five-spray schedule included the following applications: (A) Three- to four-leaf stage, (B) before bloom, (C) immediately after bloom, (D) 2 weeks after bloom, and (E) 4 weeks after bloom. A three-spray schedule included the following applications: (A) Before bloom, (B) immediately after bloom, and (C) 2 weeks after bloom, while a two-spray schedule consisted of applications (A) immediately after bloom and (B) 2 weeks after bloom. Final data on disease occurrence in the various plots were recorded during September.

## THE CAUSAL FUNGI

For the benefit of growers who may refer to this bulletin for information on the control of grape diseases, a brief discussion of the life history of the fungi which cause the diseases will provide an explanation as to why certain applications of fungicides are necessary and furnish a better understanding as to the nature of the diseases.

The first symptoms of infection by the black rot fungus, *Guignardia bidwellii,* may be observed during the latter part of June when the typical spots appear on the leaves (Fig. 1). Shortly after bloom, some of the berries may show tan-colored spots, indicating infection by the fungus. These diseased berries gradually turn black and dry up. At this time, the conidia or asexual spores are produced and spread the disease to healthy bunches of grapes thruout the remainder of the summer (Fig. 2). This is the so-called secondary infection. The diseased berries fall to the ground where the fungus remains dormant during the winter. By the first part of June, the spore-producing structures, known as perithecia, have matured and are ready to produce ascospores which will infect the leaves and young bunches of grapes during rainy weather, thus initiating the primary infection. Sprays which are applied so as to control the primary infection are important, as well as later sprays aimed to prevent the secondary infection. It also is possible that eradicant fungicides applied to the soil might reduce the disease carry-over.

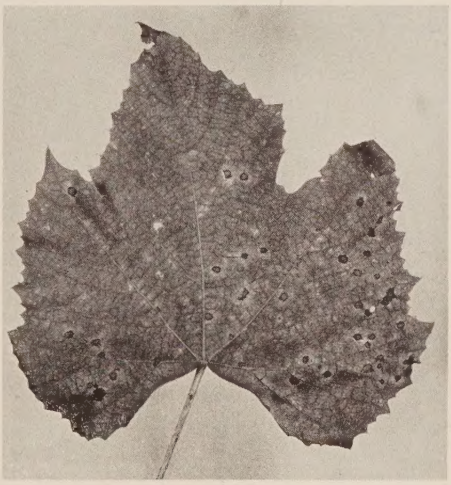

FIG. 1.—TYPICAL BLACK ROT LESIONS ON A CONCORD GRAPE LEAF.

Downy mildew, *Plasmopara viticola,* may cause a rot of the bunches or defoliation of the vines (Figs. 3 and 6). Thus, the downy mildew can injure the vines by premature defoliation, as well as causing a rot of the bunches of grapes. This fungus spends the winter in the dead, diseased leaves and bunches in which the oospores were produced during the summer. The oospores are set free by the rotting of the leaf tissue in the spring. Under suitable moisture conditions, the oospores germinate and form swarmspores which are splashed by the rain onto the young leaves. This usually occurs during the month

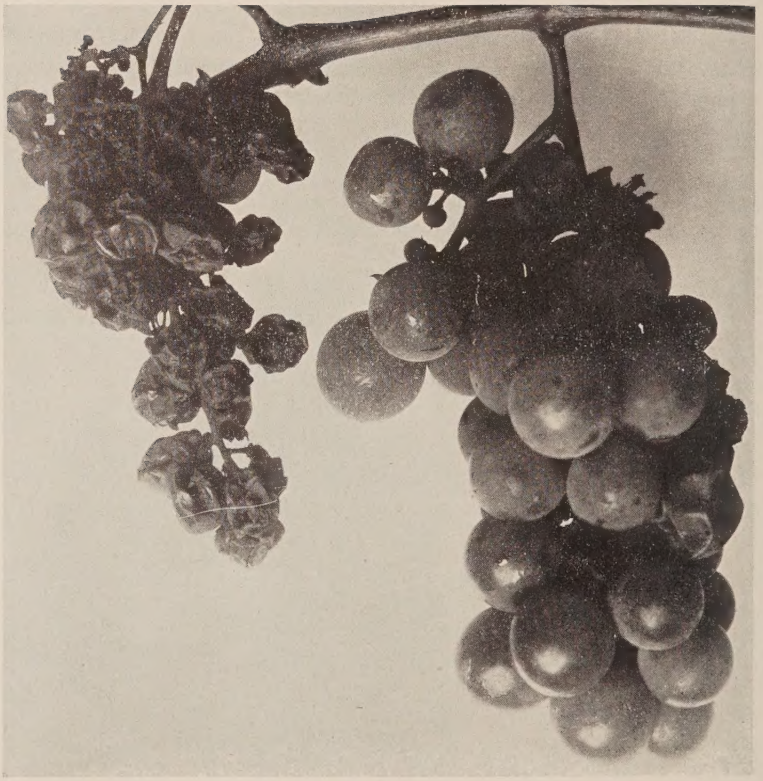

FIG. 2.—BUNCHES OF CONCORD GRAPES SHOWING BLACK ROT.

of June and constitutes the primary infection. After about 10 days, the spots, which are at first yellowish in color later becoming brown, will show the presence of white masses of conidia produced by the fungus on the under side of the leaf. These conidia spread the disease to other leaves and bunches thruout the summer whenever weather conditions are favorable. Thus, the secondary infection has occurred and the cycle is completed. The proper application of sprays to control the primary and secondary infection is necessary for satisfactory results, while eradicant fungicides applied to the soil might give some control of the overwintered phase of the fungus.

Powdery mildew, *Uncinula necator,* has a life history similar to that of the fungi that cause black rot and downy mildew. The powdery mildew fungus forms fruiting bodies called perithecia on the diseased leaves (Fig. 4) and bunches (Fig. 5) during the latter part of the

FIG. 3.—BUNCHES OF GRAPES SHOWING THE EFFECT OF ROT BY DOWNY MILDEW.

summer. These diseased leaves and bunches fall to the ground where the fungus remains until next June. By this time, the perithecia have become mature and will produce ascospores under suitable weather conditions. The ascospores will produce the primary infection on the leaves and young bunches. After about 10 days, conidia are produced in the diseased spots and spread the disease to the healthy leaves and bunches. This secondary infection continues thruout the summer whenever weather conditions are suitable. Powdery mildew infection appears as a superficial, whitish growth on the upper surface of the leaves, berries, stems, and pedicels of the bunches, while the black rot and downy mildew both produce definite dead areas in the leaves and a rot of the berries. Sprays applied to give protection from the primary and secondary infection periods should control the powdery mildew.

## VARIETAL SUSCEPTIBILITY

During the course of the investigations on the control of grape diseases, many varieties of grapes were observed in various vineyards thruout the State. Records of disease occurrence on all the varieties grown in the State were not attempted, but it seemed advisable to include those on which specific information on disease occurrence had

FIG. 4.—CONCORD LEAVES ATTACKED BY POWDERY MILDEW.

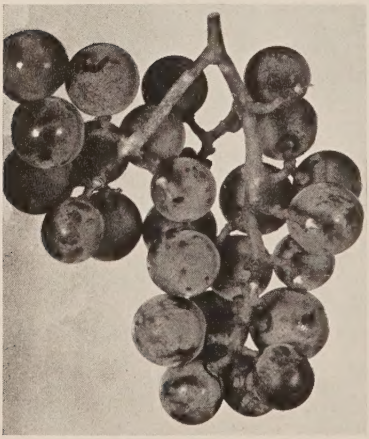

FIG. 5.—A BUNCH OF CONCORD GRAPES SHOWING POWDERY MILDEW ON THE STEMS.

been obtained. Notes were made as to whether the disease was present on the leaves or bunches, or on both, and the severity of the disease. The amount of disease recorded was the maximum observed at any time during the period of 1940 to 1944, inclusive, and shows the relative susceptibility of the variety. It does not mean that the recorded severity of the disease was present in all vineyards thruout the State.

Clinton was the only one of the 11 varieties observed on which no diseases were found (Table 1). Catawba and Niagara showed more disease than any of the others. Black rot was not found on Delaware, Elvira, Ives, and Missouri Riesling, while downy mildew was not found on Concord (Table 1). All three of the diseases were found on Catawba, Fredonia, Golden Muscat, and Niagara. Some differences in susceptibility of leaves and bunches were found. Delaware leaves were very susceptible to downy mildew, but this disease was not found on the bunches. With Fredonia, the reverse was true, the bunches were severely diseased while the leaves showed only a slight amount (Table 1). Out of the 11 varieties noted, 6 were susceptible to black rot, 9 were susceptible to downy mildew, and 7 were susceptible to powdery mildew. These observations of the susceptibility of the grape varieties to black rot and downy mildew in New York State agree with the results obtained by Demaree, *et al.* (5) who reported on the susceptibility of 270 varieties under Maryland conditions.

TABLE 1.—OCCURRENCE OF BLACK ROT, DOWNY MILDEW, AND POWDERY MILDEW ON 11 GRAPE VARIETIES IN NEW YORK STATE.*

| VARIETY | BLACK ROT | | DOWNY MILDEW | | POWDERY MILDEW | |
|---|---|---|---|---|---|---|
| | On leaves | On bunches | On leaves | On bunches | On leaves | On bunches |
| Catawba | ++ | +++ | +++ | +++ | + | ++ |
| Clinton | 0 | 0 | 0 | 0 | 0 | 0 |
| Concord | ++ | +++ | 0 | 0 | +++ | +++ |
| Delaware | 0 | 0 | +++ | 0 | 0 | 0 |
| Dutchess | ++ | +++ | ++ | ++ | 0 | 0 |
| Elvira | 0 | 0 | ++ | ++ | 0 | + |
| Fredonia | 0 | + | + | +++ | + | ++ |
| Golden Muscat | + | +++ | ++ | ++ | + | +++ |
| Ives | 0 | 0 | ++ | +++ | 0 | 0 |
| Missouri Riesling | 0 | 0 | ++ | +++ | + | + |
| Niagara | ++ | +++ | ++ | +++ | + | ++ |

*+ = slight; ++ = moderate; +++ = severe disease; 0 = disease not found during the period of 1940–44, inclusive.

## EXPERIMENTAL RESULTS

### BLACK ROT CONTROL

One phase of the investigations on the control of black rot was to determine if a dormant application of Elgetol would aid in the control of black rot by eradicating the overwintering stage of the fungus in the soil. One per cent Elgetol was applied to the soil in the vineyard at the rate of 500 gallons per acre. While the soil was being sprayed, the vines also were sprayed. When this application was made, the buds were just starting to break open. This treatment was applied to the plots in one vineyard in 1940 and four vineyards in 1941. The disease occurrence in the 1940 test was low and no effect was noted from the application of Elgetol (Table 2). In 1941, black rot did not appear in two vineyards because of dry weather, while the disease occurrence at farm No. 1 was about 50 per cent and at farm No. 2 only 3 per cent. A 10 per cent reduction in the disease was obtained at farm No. 1 when compared with the nonsprayed plots (Table 2). When results from the plots receiving the dormant and cover sprays were compared with the results obtained from the plots which received the cover sprays only, the difference was not significant. From these limited tests it is questionable as to whether the additional dormant application of Elgetol is of any value.

Shay (10) reported that the results obtained in 1944 in Arkansas showed that plots which received the eradicant spray only had about

the same amount of infection as those plots which received only a protectant spray program. Additional tests with Elgetol in the Finger Lakes region of New York should be made to correlate with the results from other sections.

TABLE 2.—RESULTS OF A DORMANT APPLICATION OF ELGETOL FOR THE CONTROL OF BLACK ROT ON CONCORD GRAPES.

| SPRAYS APPLIED | PERCENTAGE DISEASED BUNCHES | | |
|---|---|---|---|
| | 1940 | 1941 | |
| | | Farm No. 1 | Farm No. 2 |
| Nonsprayed | 8.1 | 48.3 | 3.0 |
| Dormant* | 8.0 | 38.4 | 3.0 |
| Cover only† | 1.9 | 10.5 | 0.5 |
| Dormant plus cover | 2.2 | 6.7 | 0.2 |

*Elgetol, 1 gallon in 100 gallons, applied to vines and ground beneath vines.
†Bordeaux mixture, 8–8–100, in three applications, *viz.*, before bloom, after bloom, and 2 weeks after bloom.

Another phase of the black rot problem was to determine the effectiveness of different concentrations of bordeaux mixture and insoluble copper fungicides. Three tests were conducted in 1940. Satisfactory control was obtained with concentrations of bordeaux mixture ranging from 2–2–100 to 8–8–100 (Table 3). Cuprocide 54–Y, Yel-

TABLE 3.—RESULTS OF SPRAYING EXPERIMENTS FOR THE CONTROL OF BLACK ROT.

| FUNGICIDE* | FORMULA | PERCENTAGE OF DISEASED BUNCHES | | | |
|---|---|---|---|---|---|
| | | 1940 | | | 1941, Concord† |
| | | Farm No. 1, Niagara | Farm No. 2, Concord | Farm No. 3, Concord | |
| Nonsprayed | ——— | 98.2 | 52.3 | 8.1 | 48.3 |
| Bordeaux mixture | 8–8–100 | 10.1 | 0.3 | 0.2 | 0.0 |
| Bordeaux mixture | 4–4–100 | —— | 0.1 | —— | —— |
| Bordeaux mixture | 3–3–100 | 7.4 | —— | 3.6 | 1.1 |
| Bordeaux mixture | 2–2–100 | —— | 0.3 | —— | —— |
| Cuprocide 54-Y | 2–100 | 4.5 | 1.1 | 0.3 | —— |
| Yellow Cuprocide | 1½–100 | 2.7 | —— | 2.4 | 10.0 |
| Basicop | 2–100 | 16.3 | —— | —— | —— |
| Copper Compound A | 2–100 | 8.2 | —— | —— | —— |

*Standard schedule of five applications was used. S. E. C. oil (self-emulsifying cottonseed oil), 1 pint–100 gallons, added to all sprays.
†Three applications only, *viz.*, before bloom, after bloom, and 2 weeks after bloom. Lime, 4–100, added to Yellow Cuprocide.

low Cuprocide, and Copper Compound A gave control equal to or superior to that obtained with the bordeaux (Table 3). Basicop was not as effective as the other insoluble coppers tested.

In the 1940 tests, injury occurred in those plots which received the insoluble coppers. This injury was characterized by reduced yield, smaller, yellowish leaves, and reduced vine growth. Subsequent data (11, 12) have shown that if the insoluble coppers are used at concentrations greater than ½ pound of metallic copper per 100 gallons, lime should be added at the rate of 1 pound for each ¼ pound of actual copper to alleviate the injury.

In connection with the experiments conducted at farm No. 1 in 1940, a series of plots were sprayed to determine the relative importance of the different applications which are included in a standard five-spray schedule. In one treatment, all five sprays were applied; in the second, the first application was omitted and the other four sprays applied; in the third, the second application was omitted and the other four sprays applied; and so on until each application had been omitted. The data obtained from this experiment showed that the third application, which was made after bloom, was the most important since 54.8 per cent of the bunches were diseased when it was omitted even tho the other four applications had been made (Table 4). The second, or before-bloom application, was next in importance since 18.7 per cent of the bunches were diseased when it was omitted (Table 4). The amount of disease that occurred when any of the other three applications were omitted was approximately the same. This would indicate that a three-spray schedule, *viz.*, before bloom, immediately after bloom, and 2 weeks after bloom, should give a satisfactory control of black rot.

Tests were conducted in four vineyards during 1941 to test the effectiveness of the three-spray schedule. Because of low disease occurrence, however, data were obtained from only one vineyard. Bordeaux mixtures of 8–8–100 and 3–3–100 both gave excellent control of black rot (Table 3). Since this was a small vineyard, only one insoluble copper, Yellow Cuprocide, was included in the test. The Yellow Cuprocide plus lime which was used in 1941 did not give as good control of black rot as Yellow Cuprocide alone which was used in the 1940 tests (Table 3). However, no copper injury occurred in the 1941 tests when the lime was added.

During 1942 and 1943, no experiments were conducted on the

Table 4.—Effect of Omitting Sprays on the Control of Black Rot in Niagara Grapes in 1940.

| Application omitted* | Percentage of diseased bunches |
|---|---|
| None | 10.1 |
| First | 12.3 |
| Second | 18.7 |
| Third | 54.8 |
| Fourth | 11.5 |
| Fifth | 9.6 |
| Nonsprayed | 98.2 |

*Bordeaux mixture, 8–8–100. Standard schedule of five applications, *viz.*, four-leaf stage, before bloom, immediately after bloom, 2 weeks after bloom, and 4 weeks after bloom.

control of black rot since no vineyards were found in which black rot was prevalent. The 1944 tests were made in a Concord vineyard that showed 70 per cent black rot in 1943. In these tests, the after-bloom application was delayed 3 days because of rain which allowed an infection period to occur without the necessary protection. As was shown in Table 4, this after-bloom application is the critical phase in the spray schedule. Consequently, the black rot control was not satisfactory except on those plots which received three applications of Fermate, 2–100 (Table 5). In this experiment where one application was not properly timed, five applications of bordeaux mixture, 4–4–100, were superior to three applications (Table 5). The most important information obtained in the 1944 tests was the effectiveness of Fermate for the control of black rot. Another organic fungicide, U. S. R. No. 604, also gave better control of black rot than the same number of applications of a copper fungicide (Table 5); however, this material is only in the experimental stage at the present time.

Table 5.—Efficiency of Different Fungicides for the Control of Black Rot on Concord Grapes in 1944.

| Fungicide | Formula* | Number of applications | Percentage of diseased bunches |
|---|---|---|---|
| Nonsprayed | ——— | – | 66.2 |
| Fermate | 2–100 | 3 | 4.9 |
| Bordeaux mixture | 4–4–100 | 5 | 10.2 |
| U. S. R. No. 604 | ½–100 | 3 | 19.7 |
| Bordeaux mixture | 8–8–100 | 3 | 23.6 |
| Bordeaux mixture | 3–3–100 | 3 | 38.9 |
| Microgel | 2–4–100 | 3 | 49.5 |
| Copper oxychloride sulfate | 2–4–100 | 3 | 51.3 |

*Rosin fish oil soap, 1½–100, added to bordeaux mixture; and S. E. C. oil, 1 pint–100, added to other spray mixtures.

No data have been obtained on the control of black rot in the Finger Lakes region, so it would be advisable to test the schedule in that area. Further studies are needed with copper sprays and Fermate, especially during a severe black rot infestation, before a final spray schedule for black rot control can be recommended.

### DOWNY MILDEW CONTROL

The ideal way to control downy mildew would be the use of an eradicant fungicide applied to the soil in the spring when the buds start to break. Theoretically, this would eliminate the overwintering stage of the fungus. Experiments were conducted in 1941 and 1943 to determine if 1 per cent Elgetol applied to the ground at the rate of 500 gallons per acre would control the disease. The disease occurrence in 1941 was low because of dry weather and a dormant application of the Elgetol gave good control (Table 6). Only 0.2 per cent of the leaves were diseased when the cover sprays only were applied, while the dormant and cover sprays allowed 0.04 per cent diseased leaves (Table 6). Downy mildew was severe in 1943 and the Elgetol plots showed 70 per cent of the leaves diseased (Table 6). In those plots where only the cover sprays were applied, 8.4 per cent of the leaves were diseased, while the dormant plus cover spray plots showed 8.7 per cent diseased leaves (Table 6). During a year when the downy mildew was severe, the dormant application of Elgetol did not aid in the control of the disease.

TABLE 6.—RESULTS OF A DORMANT APPLICATION OF ELGETOL ON THE CONTROL OF DOWNY MILDEW ON DELAWARE GRAPES.

| SPRAYS APPLIED | PERCENTAGE OF LEAVES DISEASED | |
|---|---|---|
| | 1941 | 1943 |
| Nonsprayed | 23.40 | 100.0 |
| Dormant* | 2.10 | 70.0 |
| Cover only† | 0.20 | 8.4 |
| Dormant and cover | 0.04 | 8.7 |

*Elgetol, 1 gallon to 100 gallons, applied April 18, 1941, and May 13, 1943.
†Bordeaux mixture, 3–3–100, applied June 3, June 25, and July 17, 1941; June 18, July 9, and August 2, 1943.

On some varieties of grapes, downy mildew induces a greater loss by attacking the bunches, while on other varieties, the principal damage is caused by the defoliation of the vines. In 1940, excellent control of the fruit rot was obtained on the Catawba variety with three

applications of the copper fungicides (Table 7). There was no significant difference in the percentage of diseased bunches when bordeaux mixture 8–8–100 or 3–3–100, Yellow Cuprocide, Cuprocide 54–Y, or Basicop was used. Copper Compound A was not as effective as the other copper materials (Table 7). Only two applications of two concentrations of bordeaux mixture were made in a small vineyard of the Fredonia variety in 1941. There was no difference between the results obtained with the 8–8–100 and the 3–3–100 bordeaux mixture (Table 7). These limited tests indicated that three applications of a suitable copper fungicide, if thoroly applied so as to give a protective covering to the bunches, would control the downy mildew on the bunches.

Table 7.—Results of Spraying Experiments for the Control of Downy Mildew Rot on Grape Bunches.*

| Fungicide | Formula | Percentage of diseased bunches | |
|---|---|---|---|
| | | 1940 Catawba | 1941 Fredonia |
| Nonsprayed | ——— | 36.2 | 19.0 |
| Bordeaux mixture | 8–8–100 | 0.9 | 4.3 |
| Bordeaux mixture | 3–3–100 | 1.8 | 5.9 |
| Yellow Cuprocide | 1–100 | 2.1 | — |
| Cuprocide 54-Y | 1½–100 | 0.6 | — |
| Basicop | 2–100 | 0.3 | — |
| Copper Compound A | 2–100 | 6.3 | — |

*Three applications in 1940, *viz.*, before bloom, immediately after bloom, and 2 weeks after bloom. Two applications in 1941, *viz.*, immediately after bloom and 2 weeks after bloom.

Investigations were started in 1941 in a Delaware vineyard to determine the relative efficiency of different concentrations of bordeaux mixture and the effectiveness of some insoluble coppers and organic fungicides for the control of defoliation by downy mildew. The three-spray schedule was used. During 1941, which was a dry season, all fungicides tested gave excellent control of the disease (Table 8).

In 1942, the nonsprayed plots were completely defoliated by September 9 (Fig. 6), while the adjacent plots which had been sprayed with bordeaux mixture, 3–3–100, had retained maximum foliage (Fig. 7), even tho 14.8 per cent of the leaves were diseased (Table 8). There was no significant difference between the results obtained in 1942 with the 8–8–100 and the 3–3–100 bordeaux mixture (Table 8). Altho the tribasic copper sulfate, copper oxychloride sulfate, and

TABLE 8.—EFFICIENCY OF DIFFERENT FUNGICIDES FOR THE CONTROL OF DOWNY MILDEW ON DELAWARE GRAPES.

| FUNGICIDE | FORMULA | PERCENTAGE OF DISEASED LEAVES | | | | |
|---|---|---|---|---|---|---|
| | | 1941* | | 1942† | 1943† | 1944‡ |
| | | A | B | | | |
| Nonsprayed | ——— | 23.4 | —— | 100.0 | 100.0 | 14.9 |
| Bordeaux mixture | 8–8–100 | 0.1 | 0.1 | 11.1 | —— | —— |
| Bordeaux mixture | 4–4–100 | —— | —— | —— | 10.9 | 1.5 |
| Bordeaux mixture | 3–3–100 | 0.1 | 0.1 | 14.8 | —— | —— |
| Bordeaux mixture | 2–2–100 | —— | —— | —— | 18.0 | —— |
| Tribasic copper sulfate | 1–100 | 0.3 | —— | 31.2 | —— | —— |
| Tribasic copper sulfate and lime | 2–4–100 | 0.2 | | —— | —— | —— |
| Yellow Cuprocide | ½–100 | 0.1 | 0.1 | —— | —— | —— |
| Yellow Cuprocide and lime | 1–4–100 | 0.1 | 0.1 | —— | —— | —— |
| Copper oxychloride sulfate | 1–100 | 0.2 | —— | 26.5 | 8.0 | 1.5 |
| Copper oxychloride sulfate and lime | 2–4–100 | 0.1 | —— | —— | —— | —— |
| Fermate | 1–100 | 0.8 | 1.3 | 33.7 | —— | —— |
| Fermate and lime | 1–½–100 | 2.4 | 5.7 | —— | | —— |
| Fermate | 2–100 | 0.7 | —— | 22.5 | —— | 3.4 |
| Fermate and lime | 2–1–100 | 0.8 | —— | —— | —— | —— |
| Microgel | 1–100 | —— | —— | —— | —— | 1.2 |
| U. S. R. No. 604 | 1–100 | —— | —— | —— | 1.6 | —— |
| U. S. R. No. 604 | ½–100 | —— | —— | —— | —— | 0.3 |

*A, no spreader-sticker; B, 1 pint S. E. C. oil added to sprays.
†Rosin fish oil soap, 1 lb. to 100, added to all sprays.
‡Rosin fish oil soap, 1 lb., added to bordeaux mixture, and 1 pint S. E. C. oil added to other sprays.

Fermate were used at low dosage in 1942, and altho these plots had considerably more diseased leaves than the bordeaux mixture plots (Table 8), they showed very little defoliation and matured a satisfactory crop. In the plots which were defoliated, the crop did not ripen.

Following the rather severe winter of 1942–43, it was observed that, in the Delaware plots, considerable differences in bud killing had resulted. Counts were made on May 28, 1943, to determine the amount of injury that occurred. On those vines which had been sprayed with bordeaux mixture during the 1942 season, an average of 28.9 viable primary buds per vine were found. In a buffer row which had shown 75 per cent of the leaves diseased in 1942, an average of 13.2 viable primary buds were present. In the nonsprayed

FIG. 6.—DELAWARE VINE DEFOLIATED BY DOWNY MILDEW.
Photographed on September 9, 1942.

plots which were prematurely defoliated in September, 1942, an average of only 5.4 viable primary buds occurred. These results indicate that a severe attack of downy mildew not only defoliates the vines but also weakens the buds so that they are more susceptible to winter injury.

The tests conducted in 1943 showed that a 2–2–100 bordeaux mixture did not give as effective control as 4–4–100 bordeaux mixture (Table 8). This indicates that the lowest concentration of bordeaux mixture which would give reliable control was the 3–3–100 formula. In most cases, the 4–4–100 formula would be more reliable in the hands of the grower. The 1943 sample of copper oxychloride sulfate gave very good control (Table 8). Considering that the copper concentration in this spray mixture was only equal to 2–2–100 bordeaux mixture, the results were very satisfactory. A new organic material, U. S. R. No. 604, showed exceptional control of downy mildew in the 1943 tests (Table 8), since the nonsprayed plots were 100 per cent diseased. This material is in the experimental stage at this time. It caused a few brown spots on the leaves and a few russet spots on the berries which were objectionable.

FIG. 7.—DELAWARE VINE SPRAYED WITH THREE APPLICATIONS OF BORDEAUX MIXTURE, 3–3–100, PLUS 1 POUND OF ROSIN FISH OIL SOAP.
This vine was in a sprayed row which was adjacent to the vine shown in Fig. 6. Photographed on September 9, 1942.

Further tests were conducted in 1944; however, this was a dry season and the nonsprayed plots showed only 14.9 per cent diseased leaves (Table 8). All of the fungicides tested gave good control of the disease, altho the Fermate plots showed significantly more disease than the other sprayed plots (Table 8). U. S. R. No. 604, ½–100, did not cause any injury in 1944.

In spraying for downy mildew control it is essential that a satisfactory coverage of the fungicide be obtained on both the upper and lower surfaces of the leaves. The addition of spreader-stickers to the bordeaux mixture should give a better coverage and adherence of the spray residue. Tests were conducted with eight spreader-stickers in 1943 and five spreader-stickers in 1944 to determine if they would give increased disease control when used with bordeaux mixture, 4–4–100. The results obtained from the 2 years' tests showed that in no case did a significant difference occur except between the sprayed and the nonsprayed plots (Table 9). Bordeaux mixture alone was as effective for the control of leaf infection by the downy mildew fungus as was bordeaux plus any of the spreader-stickers. When spraying for

the control of the downy mildew rot on bunches of grapes, the addition of a spreader-sticker would be necessary to obtain a satisfactory coverage of the fungicide on the berries.

### POWDERY MILDEW CONTROL

An experiment was conducted in 1942 to determine if an application of an eradicant fungicide to the soil in the spring would aid in the control of powdery mildew. Three dinitro compounds were tested and were applied to the vines and soil. The application made on the vines was sufficient to give thoro coverage, while the materials were

TABLE 9.—EFFECT OF ADDING SPREADER-STICKERS TO BORDEAUX MIXTURE, 4–4–100, FOR THE CONTROL OF DOWNY MILDEW ON DELAWARE GRAPES.

| SPREADER-STICKER | AMOUNT PER 100 GALLONS | PERCENTAGE OF DISEASED LEAVES | |
|---|---|---|---|
| | | 1943 | 1944 |
| Nonsprayed | ——— | 100.0 | 14.9 |
| None | ——— | 8.4 | 1.3 |
| Rosin fish oil soap | 1 pound | 10.9 | 1.5 |
| S. E. C. oil | 1 pint | 9.4 | 1.5 |
| Grasselli spreader-sticker | 4 ounces | 9.1 | 1.7 |
| Triton B-1956 | 4 ounces | 5.4 | 1.3 |
| Spraysoy A | 8 ounces | 7.8 | 0.5 |
| Liquid Orthex | 1 quart | 10.8 | —— |
| Summer oil* | 1 quart | 7.0 | —— |
| Kerosene emulsion† | 1 quart | 8.0 | —— |

*A 45-second viscosity oil containing 4 per cent Triton B-1956.
†Made of 1 part sulfonated oil base and 4 parts of kerosene.

applied to the soil at the rate of 500 gallons to the acre. The results showed that when Elgetol was applied only to the vines, a reduction of 60 per cent in the percentage of diseased bunches occurred, while if it was applied to the vines and the soil, a reduction of 74 per cent in the amount of disease was obtained, when compared with that which occurred in the nonsprayed plots (Table 10).

Elgetol 312 and D. N. Powder, D-145, were not as effective as Elgetol for the control of powdery mildew. However, if only the two cover sprays were applied, only 2.8 per cent of the bunches were diseased (Table 10). When the cover sprays were applied to the plots which also had received a dormant spray, there was no significant difference between them and the plots which had received only the two cover sprays (Table 10). While a large reduction in the disease occurred when the dormant spray only was used, the results obtained did not show that this application was of any value when compared

with the effectiveness of the two cover sprays without the dormant application.

TABLE 10.—RESULTS OF DORMANT SPRAYING WITH DINITRO COMPOUNDS FOR THE CONTROL OF POWDERY MILDEW ON CONCORD GRAPES, 1942.

| MATERIAL* | APPLIED TO | PERCENTAGE OF DISEASED BUNCHES | |
|---|---|---|---|
| | | No cover spray | Two cover sprays† |
| Nonsprayed | ——— | 98.0 | 2.8 |
| Elgetol, 1% | Vines only | 36.1 | 3.7 |
| Elgetol, 1% | Vines and soil | 24.0 | 2.8 |
| Elgetol 312, 1% | Vines only | 53.4 | 4.3 |
| Elgetol 312, 1% | Vines and soil | 45.0 | 5.1 |
| D-145, 4–100 | Vines only | 53.0 | 2.3 |
| D-145, 4–100 | Vines and soil | 38.1 | 2.3 |

*Dormant sprays applied on April 28, 1942.
†Bordeaux mixture, 2–4–100, plus 3 lbs. lead arsenate and 1½ lbs. rosin fish oil soap applied on June 22 and July 7, 1942.

Bordeaux mixture, 8–8–100, has been suggested for the control of powdery mildew (4, 7). Experiments were conducted during 1942 and 1943 to determine whether this high concentration was required. The data show that bordeaux mixture at 8–8–100, 4–4–100, and 2–4–100 was equally satisfactory for the control of powdery mildew in both 1942 and 1943 (Table 11). Bordeaux mixture, 2–4–100, was used in place of a 2–2–100 formula since it was necessary to have the increased amount of lime to counteract the lead arsenate which is used for berry moth control in the Lake Erie grape belt. The addition of rosin fish oil soap to 2–4–100 bordeaux mixture resulted in a significant reduction in the percentage of diseased bunches when compared with the disease that occurred when bordeaux mixture, 2–4–100, was used without the spreader-sticker (Table 11).

TABLE 11.—EFFECTIVENESS OF DIFFERENT CONCENTRATIONS OF BORDEAUX MIXTURE FOR THE CONTROL OF POWDERY MILDEW ON CONCORD GRAPES.

| CONCENTRATION* | PERCENTAGE OF DISEASED BUNCHES | |
|---|---|---|
| | 1942 | 1943 |
| Nonsprayed | 98.0 | 100.0 |
| 8–8–100 | 0.5 | 1.0 |
| 4–4–100 | 2.5 | 0.0 |
| 2–4–100 | 2.8 | 0.5 |
| 2–4–100† | 11.9 | —— |

*Lead arsenate, 3–100, and rosin fish oil soap, 1½–100, added to the bordeaux mixture. Applied immediately after bloom and 10 to 14 days after bloom.
†No rosin fish oil soap added.

Tests were conducted also with S. E. C. oil, summer oil, and kerosene emulsion to determine their efficiency when added to the 2–4–100 bordeaux mixture. When S.E.C. oil, 1 pint to 100 gallons, was added, 3.1 per cent of the bunches were diseased, while summer oil at 1 quart to 100 gallons showed 2.5 per cent diseased bunches which indicates that these materials were as effective as the rosin fish oil soap. Plants sprayed with the addition of kerosene emulsion, 1 quart to 100 gallons, showed 8.9 per cent diseased bunches, indicating that this material was not satisfactory.

TABLE 12.—EFFICIENCY OF VARIOUS FUNGICIDES FOR THE CONTROL OF POWDERY MILDEW ON CONCORD GRAPES, 1942.

| FUNGICIDE | FORMULA* | PERCENTAGE OF DISEASED BUNCHES | |
|---|---|---|---|
| | | Farm No. 1 | Farm No. 2 |
| Nonsprayed | ——— | 98.0 | 92.0 |
| Fermate | 2–100 | 35.0 | 79.0 |
| Yellow Cuprocide | 1–100 | 8.4 | 4.5 |
| Tribasic copper sulfate | 2–100 | 9.4 | 15.4 |
| Copper oxychloride sulfate | 2–100 | 16.5 | 8.0 |
| Lead arsenate and lime | 3–4–100 | 60.0 | ——— |
| Bordeaux mixture | 2–4–100 | 2.8 | 1.5 |

*Lead arsenate, 3–100; lime, 4–100; and rosin fish oil soap, 1½–100, added to all treatments. Applied immediately after bloom and 10 to 14 days after bloom.

During 1942, experiments were conducted in two vineyards to determine the effectiveness of Yellow Cuprocide, tribasic copper sulfate, copper oxychloride sulfate, and Fermate for the control of powdery mildew. None of the insoluble coppers gave as good control as the 2–4–100 bordeaux mixture (Table 12). Fermate was not satisfactory for the control of powdery mildew (Table 12). Lead arsenate and lime alone gave some reduction in the percentage of diseased bunches (Table 12).

## DISCUSSION

The spray schedules suggested for the control of grape diseases thruout the United States vary according to the diseases present and the varieties grown. In the western part of the country, powdery mildew is the only disease of importance and sulfur dust is suggested for its control (*2, 3*). In New York State, sulfur dust causes severe injury to the leaves of certain varieties that are grown extensively (*7*) and, therefore, cannot be used. In the region from the Great Plains eastward, black rot, downy mildew, and powdery mildew

occur. The spray schedules (1, 6, 8, 13) all recommend bordeaux mixture as a suitable fungicide. The number of applications suggested varies from three to five, while the concentration of the bordeaux mixture recommended varies from 4–6–100 to 8–8–100.

The data presented here should clarify the situation with regard to a satisfactory spray schedule for the control of black rot, downy mildew, and powdery mildew as they occur in New York State. While a dormant application of an eradicant fungicide, such as Elgetol, to the vines and soil gave some reduction in the amount of black rot, downy mildew, and powdery mildew that occurred when compared with the disease which was present in the nonsprayed plots, it would not be economical to use this application in a spray schedule, at least according to the results obtained to date. A three-spray schedule of bordeaux mixture alone gave control equal to that obtained with the same spray treatment plus the dormant application of Elgetol.

The required concentration of bordeaux mixture that will give satisfactory control of the diseases is of importance in determining the cost of spraying. A concentration as low as 2–2–100 has given control of black rot and downy mildew in some instances and has always given control of the powdery mildew. A 4–4–100 formula gave control equal to that obtained from an 8–8–100 bordeaux mixture, formerly recommended (4, 7). The use of a 4–4–100 bordeaux mixture would result in a saving of 50 per cent in the amount of copper required to spray an acre of grapes when compared with that which would be needed for the 8–8–100 formula.

For New York State, three applications of bordeaux mixture have been suggested for the control of downy mildew, two applications for the control of powdery mildew, and five applications for the control of black rot (4, 7). The data presented here confirm the reliability of the three applications for downy mildew and the two applications for powdery mildew control. However, the results obtained indicate that, if the sprays were properly applied, three applications of the fungicide, *viz.*, before bloom, immediately after bloom, and 2 weeks after bloom, gave as effective control of black rot as was obtained with a schedule calling for five applications. In spraying for the control of all three diseases, the critical application was the one which was applied immediately after bloom. If this application was not properly timed, a greater increase in the amount of disease resulted than was the case when any of the other applications were not applied at the correct time.

The results showed that better control of the diseases on the grape bunches was obtained if a spreader-sticker was added to the bordeaux mixture. The data did not indicate any benefit from the addition of a spreader-sticker for the control of downy mildew on grape foliage, altho it was usually advisable to add such a material. Of the eight spreader-stickers tested, rosin fish oil soap, S. E. C. oil, Spraysoy A, Grasselli spreader-sticker, and Triton B-1956 were equally effective.

During the course of the investigations, a total of seven insoluble coppers were tested for their ability to control black rot, downy mildew, and powdery mildew. While the insoluble coppers usually gave satisfactory control of the diseases, they were not, in general, as effective as 4–4–100 bordeaux mixture. When rosin fish oil soap was used with the insoluble coppers, an excess of the rosin fish oil would disrupt the physical nature of the spray mixture to such an extent that the particles of the fungicides would coagulate and be present in the foam. This did not occur when lime or lead arsenate and lime were present in the spray mixture. S. E. C. oil, Grasselli spreader-sticker, or Triton B-1956 proved to be better spreader-stickers for use with the insoluble coppers.

The injury factor should be taken into consideration if the insoluble coppers are used on grapes. If these materials are used at the rate of not more than ½ pound of metallic copper per 100 gallons of spray mixture, no injury will occur, as a rule. If used at a greater copper concentration, however, 1 pound of lime should be added for each ¼ pound of actual copper present in each 100 gallons of the spray mixture.

Two organic fungicides, U. S. R. No. 604 and Fermate, have been tested in a three-spray schedule to determine if they would control any of the three diseases. U. S. R. No. 604 is in the experimental stage and is not available, but it gave exceptional control of downy mildew and was equal to bordeaux mixture for the control of black rot. Some injury was observed when it was used at 1 pound to 100 gallons. When used at the rate of ½ pound to 100 gallons no injury was observed on Delaware, but Concord showed a slight russeting of the berries. Fermate, 2–100, gave excellent control of black rot in the one year (1944) that it was tested. It did not control powdery mildew and was not as effective as the copper fungicides for the control of downy mildew. Further data are needed before Fermate can be recommended for the control of black rot. However, the preliminary results were excellent and a grower who has a black rot problem could

try Fermate on a few rows to determine its effectiveness in his vineyard.

In all of the experimental work, the 8–8–100 bordeaux mixture spray schedules suggested in 1928 (7) and 1937 (4) always gave excellent control of the three diseases. The question arises as to why growers did not obtain control with these schedules.

During the five seasons in which the tests were conducted on the control of grape diseases, it was found that there were several factors which would influence the degree of control obtained. The method by which the bordeaux mixture was prepared governs its physical properties and would have an effect on its fungicidal value. In the experimental work the bordeaux mixture was prepared by washing the snow-form copper sulfate thru the screen into the tank full of water. After 2 or 3 minutes, during which time the agitator was running, the hydrated spray lime was washed thru the screen. If an insecticide was used it was then washed thru the screen, while the spreader-sticker was always the last ingredient to be added to the tank of spray mixture.

In spraying grapes at least 300 pounds pressure is required to carry the spray around the grape foliage and to cover the under side of the leaves on the opposite side of the vine. At the same time, the spray must give a protective coating of the fungicide on the bunches. The thoro coverage of the leaves and bunches is best obtained by spraying from both sides of the row. Better control of black rot is obtained with hand-directed spray brooms than with a fixed-boom, unless such a boom is properly arranged and operated at sufficient pressure to give the necessary coverage to the leaves and bunches.

To supply adequate coverage for disease control required 150 gallons of spray in the before bloom application and at least 200 gallons of spray mixture per acre in the later sprays. If the vines have exceptionally heavy foliage, a larger amount would be required. Even tho the fungicide is applied correctly, satisfactory control cannot be obtained unless the application is made at the proper time. This point was demonstrated several times during the course of the experimental work. In the final analysis, the principal reason why some growers failed to control the diseases is because the fungicide was not properly applied to give a thoro coverage of the leaves and bunches. In some cases the applications were not made at the correct time. A delay of 3 days apparently caused an increase in the amount of black rot that occurred in the 1944 tests.

## SUMMARY AND CONCLUSIONS

Black rot, *Guignardia bidwellii* (Ell.) Viala and Ravaz, downy mildew, *Plasmopara viticola* (Berk. and Curt.) Berl. and DeToni, and powdery mildew, *Uncinula necator* (Schw.) Burr., are the diseases of grapes which are of major importance in New York State. The susceptibility to these diseases of the leaves and bunches of 11 varieties of grapes as observed under field conditions is recorded.

Experiments were conducted from 1940 to 1944, inclusive, to determine economical spray schedules for the control of these diseases. Altho a 1 per cent solution of Elgetol applied to the soil in the spring gave some reduction in disease occurrence when compared with the nonsprayed plots, a three-spray schedule of bordeaux mixture applied to the Elgetol-treated plots did not give better control than was obtained with the bordeaux mixture alone.

Concentrations of bordeaux mixture ranging from 2–2–100 to 8–8–100, gave effective control of black rot and downy mildew in the experimental tests. However, the 4–4–100 formula would be more reliable in the hands of the grower.

The results presented here showed that excellent control of downy mildew and powdery mildew was obtained with three applications (before bloom, immediately after bloom, and two weeks after bloom) of bordeaux mixture, 4–4–100, plus 1 pound of rosin fish oil soap, if the spray was thoroly applied so as to give proper coverage of the leaves and bunches. This schedule also controlled black rot in the tests conducted in 1940 and 1941. However, five applications of bordeaux mixture were necessary in the 1944 tests. If powdery mildew was the only disease present in the vineyard, excellent control was obtained with two applications (immediately after bloom and 10 to 14 days after bloom) of bordeaux mixture, 2–4–100, plus 1 pound of rosin fish oil soap.

The addition of a spreader-sticker to the bordeaux mixture increased the disease control on the bunches but did not give any significant difference in the control of downy mildew on the foliage. Of the eight spreader-stickers tested, rosin fish oil soap, S. E. C. oil, Spraysoy A, Grasselli spreader-sticker, and Triton B-1956 were satisfactory.

Seven insoluble coppers were tested for the control of the three diseases. Except in a few isolated cases these materials were not superior to bordeaux mixture. Of the insoluble coppers tested, Yellow Cuprocide gave the best results.

Fermate, 2–100, appears very promising for the control of black rot. This fungicide gave better control of black rot than bordeaux mixture but was less effective than bordeaux for the control of downy mildew and did not control powdery mildew. An experimental organic material, U. S. R. No. 604, was better than bordeaux mixture for the control of downy mildew and equal to bordeaux mixture for the control of black rot. It caused some injury when used at a 1–100 concentration.

In observing the spray practices thruout the State, it was noted that some growers failed to obtain control of grape diseases for two reasons. First, the spray was not properly applied so as to give a thoro coverage of the leaves and bunches. Second, the sprays were not applied at the correct time.

## LITERATURE CITED


1 Beach, Frank H., Parks, T. H., and Allison, C. C. Grape growing in Ohio. *Ohio State Univ. Agr. Ext. Bul. No. 250. 1944.*

2 Beach, George, and Bryant, L. R. Grape growing in Colorado. *Colorado Agr. Exp. Sta. Bul. No. 484. 1944.*

3 Blodgett, E. C. Diseases of small fruits in Idaho. *Idaho Agr. Exp. Sta. Bul. No. 246. 1942.*

4 Crosby, C. R., Mills, W. D., and Evans, J. A. Diseases and insects of small fruits. *Cornell Univ. Agr. Ext. Bul. No. 306. 1934.* (Revised in 1937.)

5 Demaree, J. B., Dix, I. W., and Magoon, C. A. Observations on the resistance of grape varieties to black rot and downy mildew. *Proc. Amer. Soc. Hort. Sci.,* **35**: *451–460. 1937.*

6 ————————, and Runner, G. A. Control of grape diseases and insects in eastern United States. *United States Dept. Agr. Farmers' Bul. No. 1893. 1942.*

7 Gladwin, F. E. Downy and powdery mildews of the grape and their control. *New York State Agr. Exp. Sta. Bul. No. 560. 1928.*

8 Hurt, R. H. Control of grape diseases and insects. *Virginia Agr. Exp. Sta. Bul. No. 332. 1941.*

9 Mills, W. D., and Evans, J. A. Diseases and insects of small fruits. *Cornell Univ. Agr. Ext. Bul. No. 306. 1934.* (Revised in 1943.)

10 Shay, J. Ralph. Preliminary results on the effectiveness of Elgetol as an eradicant in grape black-rot control. *Phytopath.,* **34**: *1011. 1944.*

11 Suit, R. F. Relation of the concentration of copper fungicides to disease control and spray injury on grapes. *Phytopath.*, **33**: *13. 1943.*

12 ————————. New developments in grape spraying. *Proc. N. Y. State Hort. Soc.*, **88**: *22–29. 1943.*

13 Swartwout, H. G. Spraying grapes with special reference to black rot. *Missouri Agr. Exp. Sta. Circ. No. 211. 1941.*